Space Weather Technical Forecast

Issued on Saturday, 11 March 2023 at 01:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-class flares (R1-R2/Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours with occasional C-class flares. The largest a C7.1 at 10/0708UTC from AR3245. There are currently 10 numbered sunspots on the visible disc, with AR3245 the most dominant region. This has shown weakening of the trailer spots, and has given rise to most of the flares in the past 24 hours. AR3242 is the second largest region and has also shown decay in the trailer spots. A small unnumbered unipolar region is evident in the northeast. The remaining active regions are small, magnetically simple, and either stable or slowly evolving. Currently no Earth directed CMEs have been observed in available imagery, however a possible candidate has been analysed from the southwest with model results awaited.

Solar Wind / Geomagnetic Activity: The solar wind has declined erratically from 450km/s to near 400km/s. Density was around or rather below average. Total magnetic field strength was mainly weak, but a brief moderate period was observed between 10/0530-0730UTC, possibly due to a transient weak CME. The north-south component varied weakly between negative and positive levels. Phi angle was mainly negative (towards the Sun) throughout. Geomagnetic activity was mainly Quiet to Unsettled (Kp 0-3)

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at background levels. High energy electron flux (greater than 2MeV) has varied between mainly moderate and high levels, with a peak of 1980pfu at 10/1725UTC. Electron fluence has been mostly steady following a slightly declining trend. A reading of 4.26e7 was observed at 11/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low with a Chance of becoming Moderate due to two moderately large regions on the visible disc, if an isolated M-class flare were to occur. One of these is in the northwest (AR3242) and the other, larger region, in the southwest (AR3245).

Solar Wind / Geomagnetic Activity: No CMEs are currently forecast to affect the Earth in the next four days, however a possible candidate has been analysed from the southwest, originating from a plage region, and model results are awaited. Solar winds are expected to be at mainly slow-ambient levels over the next few days, with no further coronal hole HSS connections forecast, to give appreciable enhancements. Geomagnetic activity is likely to be mostly Quiet to Unsettled (Kp 0-3) throughout the period, with a Chance of an Active interval.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux, as observed by GOES16, is currently at background levels with a slight chance of reaching S1 or

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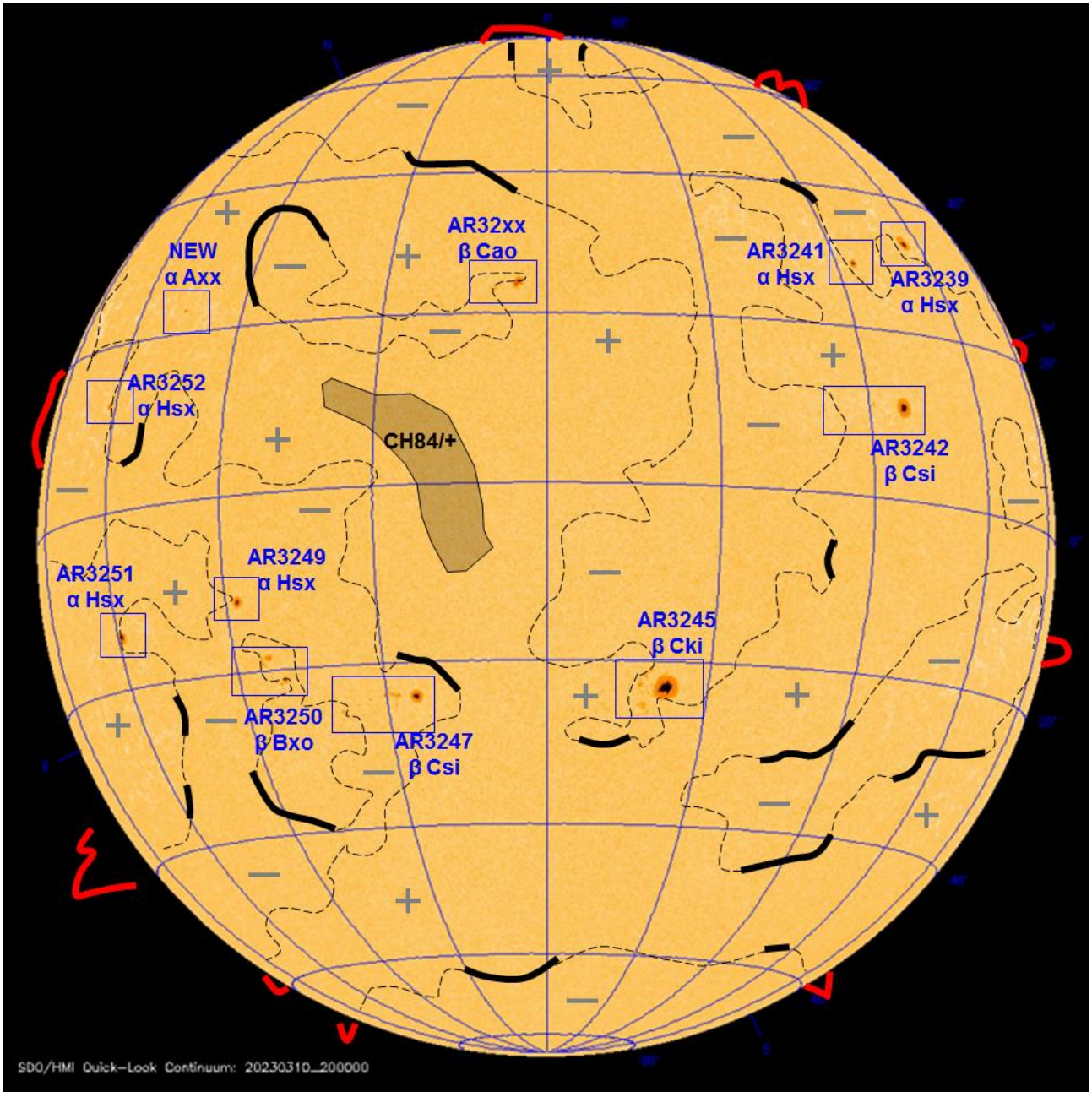
greater should any larger flares occur. High energy electron flux levels (greater than 2MeV) are expected oscillate between moderate and high levels initially, becoming mostly background to moderate. Electron fluence is expected to continue to slowly decline and probably remain below the Active threshold.

Figure 1. Solar Analysis Valid 2000UTC, 10 March 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

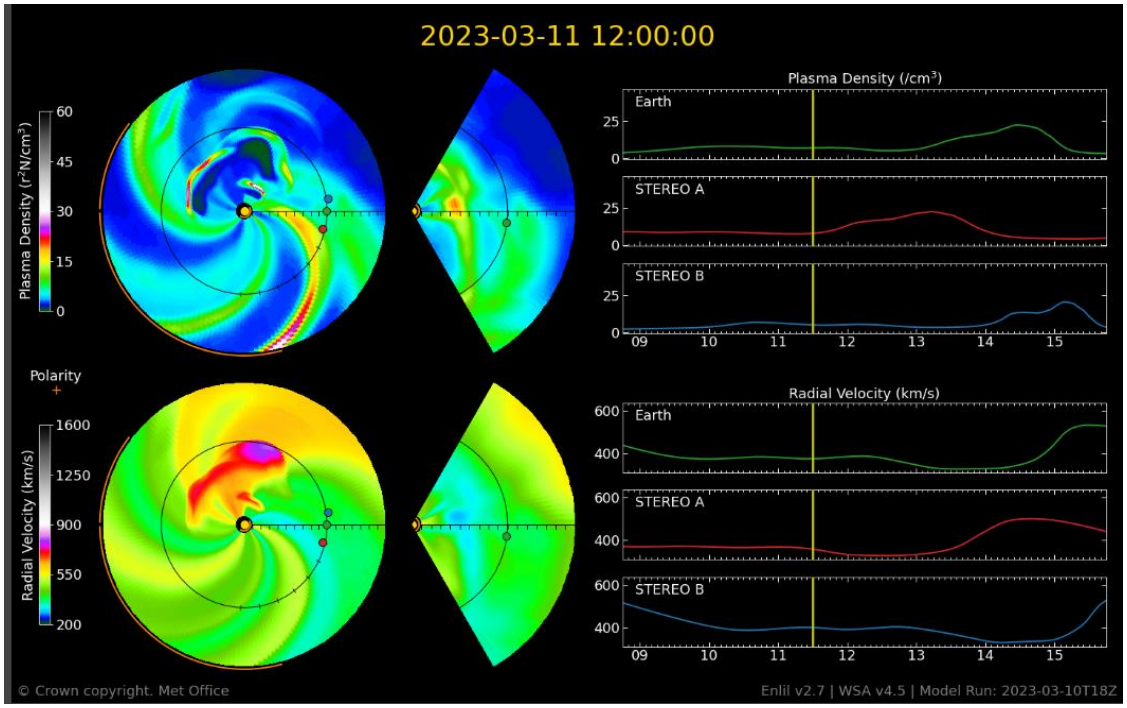
Coronal hole influence has weakened with solar winds now nearly reaching slow-ambient levels. No further coronal holes are expected to affect the Earth through the forecast period, however a positive region CH84 is due to arrive in a favourable location with a high speed stream probably reaching Earth around 15 March. Geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a Chance of an isolated Active interval (Kp 4).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

Figure 2: Met Office ENLIL output with CMEs currently missing Earth.



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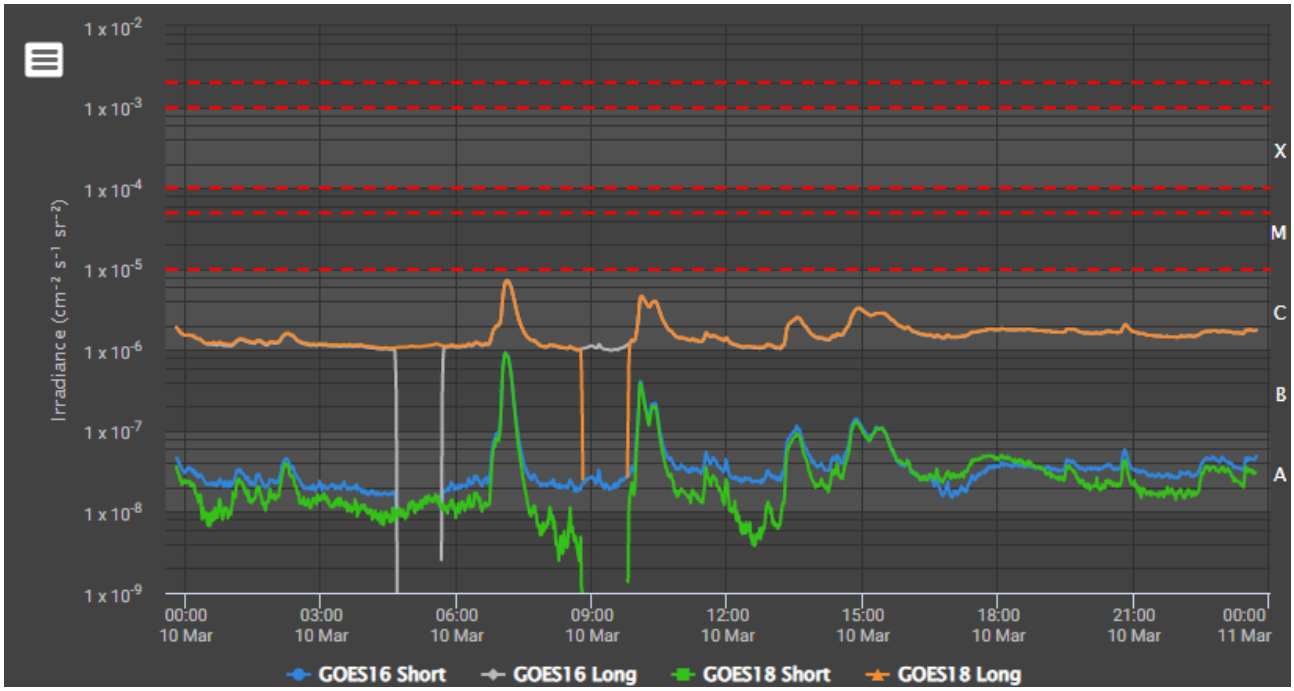
Radio Blackouts - X-Ray Flares:
Solar activity has been Low through the last 24 hours. The two main spot regions on the disc, AR3242 and AR3245 are both modestly large and responsible for the most recent C-class flares. Both regions are also showing some weakening in their trailing spots. There are eight other numbered spot regions, and these are generally small, magnetically simple, and either stable or slowly evolving. Low solar activity is forecast, with a 30% Chance of an M-class flare brining levels up to Moderate.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	30	30	20	20
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: X-ray flus plot over the past 24 hours showing a number of C-class flares.



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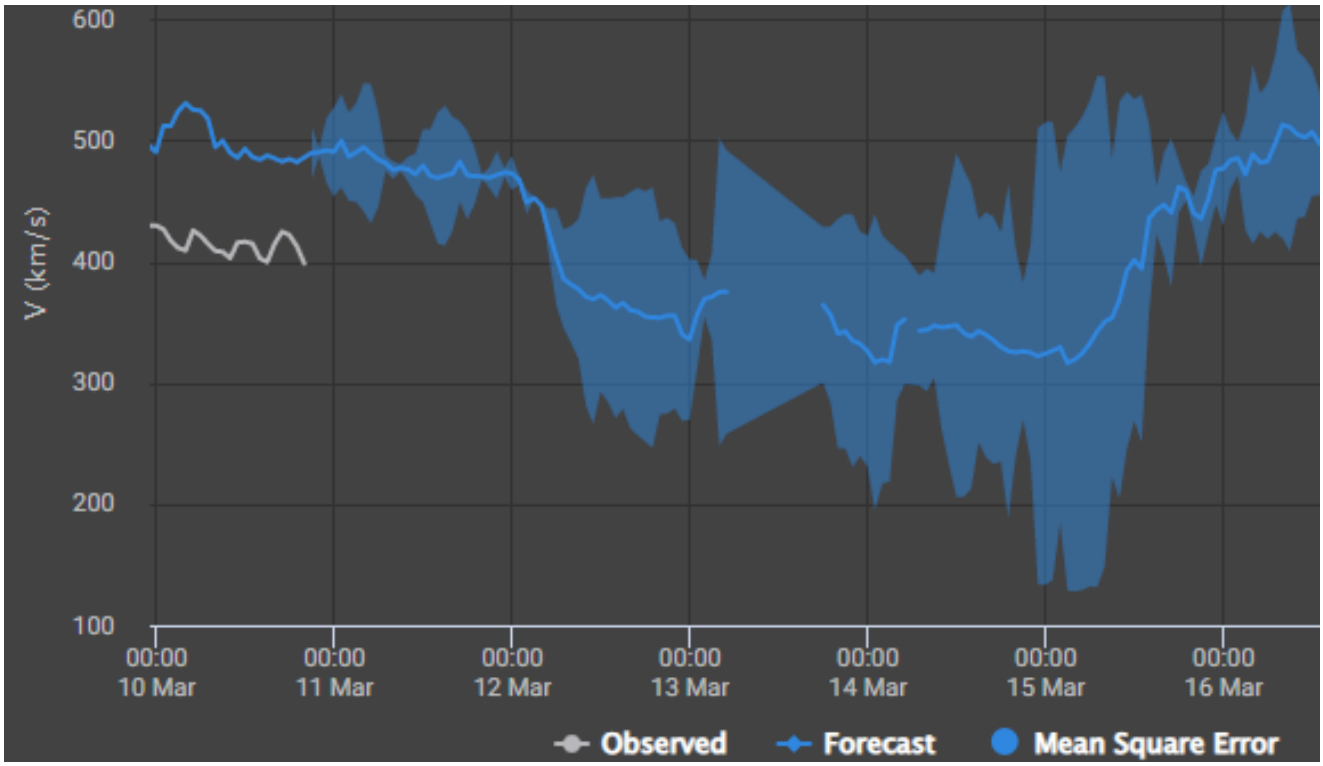
Solar Radiation Storms - (High Energy Protons):
High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. AR3242 and AR3245 pose the most elevated proton risk. AR3242 is in the northwest quadrant, with AR3245 rotating across the southwest quadrant. The flare risk has been maintained at a relatively low level as both spots transit the western hemisphere towards the limb through the guidance period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: Met Office Solar Winds Prediction Model (SWPM) showing little significant change through the four day guidance period.



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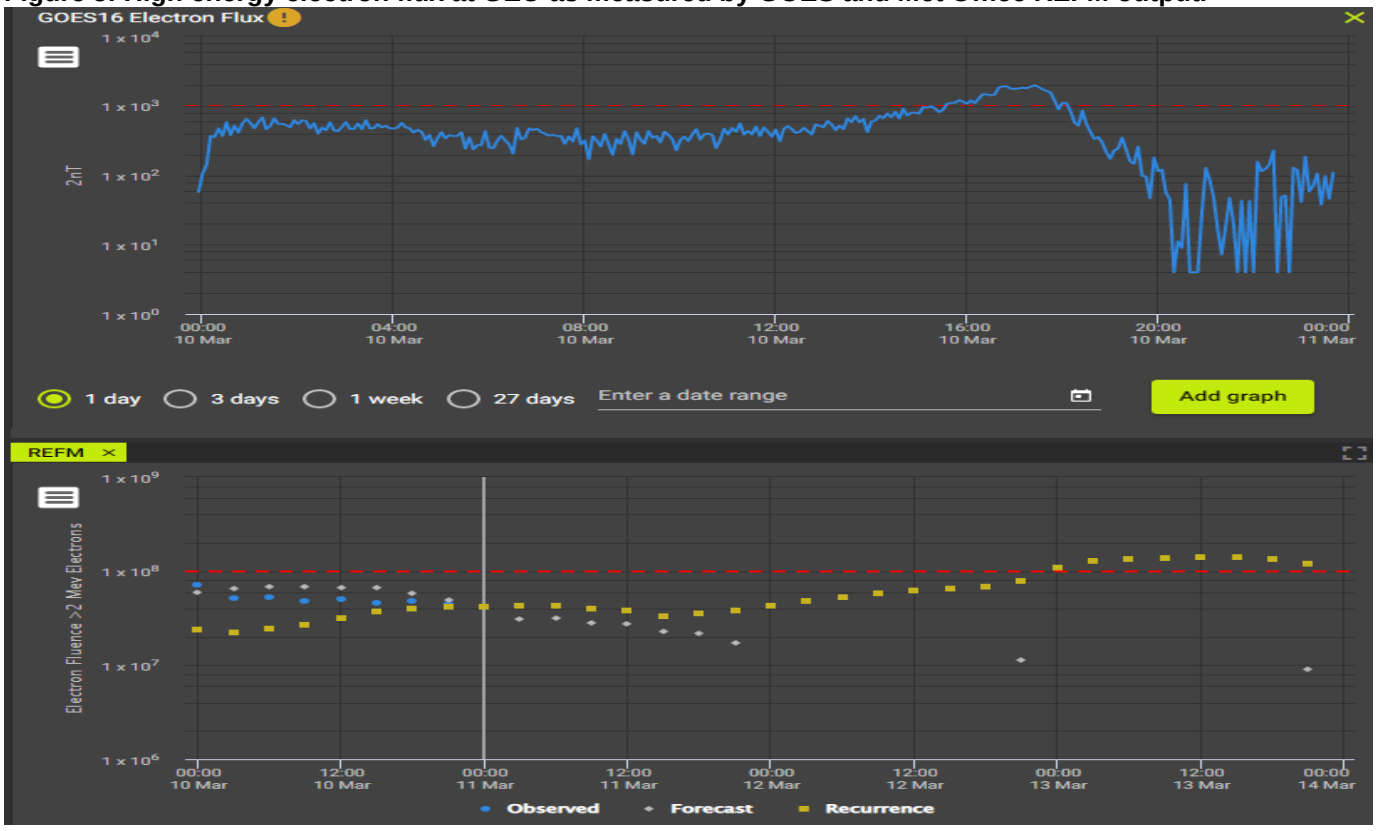
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been at mostly moderate levels through the last 24 hours, with an incursion to high levels for a time. The long-lived high speed streams (HSS) related to coronal holes 81 and 82 have now waned. In the absence of further coronal holes and with limited geomagnetic activity, electron flux is expected to continue to follow a declining trend through the period, with peaks increasingly likely to be below the high threshold through the period. The BAS radiation belt model is suggesting high electron populations in lower Earth orbits, but with no significant geomagnetic activity forecast and solar wind speeds approaching background levels there appears to be limited mechanisms for the electrons to reach higher orbits.

Electron fluence edged further down and remains below the Active threshold. Levels will probably continue to follow a gradual declining trend through the period, with no inputs or enhancements into the belts forecast from high speed streams or CMEs. The output from Met Office REFM is considered to be giving a good guide, and probabilities for reaching Active fluence are relatively low.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	5	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron flux at GEO as measured by GOES and Met Office REFM output.



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